

OUACHITA RIVER TMDLS FOR DISSOLVED OXYGEN AND NUTRIENTS

May 28, 2002

OUACHITA RIVER TMDLS
FOR DISSOLVED OXYGEN AND NUTRIENTS
SUBSEGMENT 080201

Prepared for

US EPA Region 6
Water Quality Protection Division
Watershed Management Section

Contract No. 68-C-99-249
Work Assignment #2-108

Prepared by

FTN Associates, Ltd.
3 Innwood Circle, Suite 220
Little Rock, AR 72211

May 28, 2002

EXECUTIVE SUMMARY

Section 303(d) of the Federal Clean Water Act requires states to identify waterbodies that are not meeting water quality standards and to develop total maximum daily pollutant loads for those waterbodies. A total maximum daily load (TMDL) is the amount of pollutant that a waterbody can assimilate without exceeding the established water quality standard for that pollutant. Through a TMDL, pollutant loads can be distributed or allocated to point sources and nonpoint sources (NPS) discharging to the waterbody. This report presents TMDLs that have been developed for dissolved oxygen (DO) and nutrients for the Ouachita River from Columbia Lock and Dam to Jonesville (subsegment 080201), located in northern Louisiana.

Subsegment 080201 consists of the Ouachita River from Columbia Lock and Dam (approximately 22 miles south of Monroe) to Jonesville, LA (approximately 24 miles west of Natchez, MS). The drainage area of the Ouachita River at the upstream end of this subsegment is approximately 15,677 mi². The flow in the Ouachita River is regulated by many upstream reservoirs and the hydraulics are affected by locks and dams that were built for navigation. This subsegment covers approximately 179 mi² and is over 60% forested.

Subsegment 080201 was listed on the Modified Court Ordered 303(d) List for Louisiana as not fully supporting the designated use of propagation of fish and wildlife and was ranked as priority #1 for TMDL development. The causes for impairment cited in the 303(d) List included organic enrichment/low DO and nutrients. The water quality standard for DO is 5 mg/L year round for the subsegment.

A water quality model (LA-QUAL) was set up to simulate DO, carbonaceous biochemical oxygen demand (CBOD), ammonia nitrogen, and organic nitrogen in the subsegment. The model was calibrated using LDEQ and US Geological Survey (USGS) monitoring data. The projection simulation was run at critical flows and temperatures to address seasonality as required by the Clean Water Act. Reductions of NPS loads were required for the projection simulation to show the DO standard of 5 mg/L being maintained. In general, the modeling in this study was consistent with guidance in the Louisiana TMDL Technical Procedures Manual.

A TMDL for oxygen demanding substances (CBOD, ammonia nitrogen, organic nitrogen, and sediment oxygen demand (SOD)) was calculated using the results of the projection simulation. Both implicit and explicit margins of safety (MOS) were included in the TMDL calculations. The nutrient TMDL was developed based on Louisiana's water quality standard for nutrients, which states that "the naturally occurring range of nitrogen to phosphorus ratios shall be maintained". The nutrient TMDL was calculated using allowable nitrogen loadings from the projection simulation and applying a naturally occurring nitrogen to phosphorus ratio to determine the allowable phosphorus loadings.

Two point sources were identified within subsegment 080201. Therefore, each TMDL for this subsegment includes wasteload allocations (WLAs) for both point sources and load allocations (LAs) for nonpoint sources. In order to maintain the DO standard of 5 mg/L throughout Ouachita River from Columbia Lock and Dam to Jonesville, NPS loads will need to be reduced by approximately 49%. No treatment upgrades will be needed for point source discharges because their flows are small and they do not contribute significantly to the total oxygen demand in the stream.

TABLE OF CONTENTS

1.0	INTRODUCTION	1-1
2.0	STUDY AREA DESCRIPTION	2-1
2.1	General Information	2-1
2.2	Water Quality Standards	2-2
2.3	Identification of Sources	2-3
2.3.1	Point Sources	2-3
2.3.2	Nonpoint Sources.....	2-3
2.4	Previous Data and Studies	2-3
3.0	CALIBRATION OF WATER QUALITY MODEL.....	3-1
3.1	Model Setup.....	3-1
3.2	Calibration Period	3-1
3.3	Temperature Correction of Kinetics (Data Type 4)	3-2
3.4	Hydraulics and Dispersion (Data Types 9 and 10)	3-3
3.5	Initial Conditions (Data Type 11)	3-3
3.6	Water Quality Kinetics (Data Types 12 and 13).....	3-4
3.7	Nonpoint Source Loads (Data Type 19)	3-5
3.8	Headwater, Tributary, and Incremental Flow Rates (Data Types 16, 20, and 24)	3-6
3.9	Headwater, Tributary and Incremental Inflow Water Quality (Data Types 16, 17, 20, 21, 24 and 25)	3-7
3.10	Model Results for Calibration.....	3-8
4.0	WATER QUALITY MODEL PROJECTION.....	4-1
4.1	Identification of Critical Conditions	4-1
4.2	Temperature Inputs	4-2
4.3	Headwater, Tributary, and Incremental Inputs.....	4-2
4.4	Point Source Inputs	4-3
4.5	Nonpoint Source Loads.....	4-3

TABLE OF CONTENTS (CONTINUED)

4.6	Other Inputs	4-4
4.7	Model Results for Projection	4-4
5.0	TMDL CALCULATIONS.....	5-1
5.1	DO TMDL	5-1
5.2	Nutrient TMDL.....	5-2
5.3	Summary of Source Reductions.....	5-2
5.4	Seasonal Variation	5-3
5.5	Margin of Safety	5-3
6.0	SENSITIVITY ANALYSES.....	6-1
7.0	OTHER RELEVANT INFORMATION	7-1
8.0	PUBLIC PARTICIPATION	8-1
9.0	REFERENCES	9-1

TABLE OF CONTENTS (CONTINUED)

LIST OF APPENDICES

APPENDIX A:	Maps of the Study Area
APPENDIX B:	LDEQ Water Quality Data
APPENDIX C:	HEC-2 Model of Ouachita River from Columbia Lock and Dam to Jonesville Output
APPENDIX D:	Data for Developing Hydraulic Parameters
APPENDIX E:	Model Input Calibration
APPENDIX F:	BOD Decay Rates from LDEQ 2001 Survey of Ouachita River
APPENDIX G:	Analysis of LDEQ Long-Term BOD Data
APPENDIX H:	Literature Values for Mineralization Rates
APPENDIX I:	USGS Flow Data and Drainage Area Information
APPENDIX J:	Data Used for Calculation of Input Water Quality
APPENDIX K:	Plots of Predicted and Observed Water Quality
APPENDIX L:	Printout of Model Output for Calibration
APPENDIX M:	90 th Percentile Temperature Calculations
APPENDIX N:	Model Input Data and Sources for Projection
APPENDIX O:	Published 7Q10 Information
APPENDIX P:	Plot of Predicted DO for Projection
APPENDIX Q:	Printout of Model Output for Projection
APPENDIX R:	Input File for TMDL Calculation Program
APPENDIX S:	Output from TMDL Calculation Program
APPENDIX T:	Source Code for TMDL Calculation Program
APPENDIX U:	Nitrogen to Phosphorus Ratio Data
APPENDIX V:	Ammonia Toxicity Calculations
APPENDIX W:	Responses to Comments

LIST OF TABLES

Table 1.1	Summary of 303(d) Listing of subsegment 080201.....	1-1
Table 2.1	Land uses in subsegment 080201 based on GAP data.....	2-1
Table 2.2	Water quality standards and designated uses	2-2
Table 5.1	DO TMDL for Subsegment 080201	5-1
Table 5.2	Nutrient TMDL for Subsegment 080201	5-2
Table 6.1	Summary of results of sensitivity analyses	6-2

1.0 INTRODUCTION

This report presents total maximum daily loads (TMDLs) for dissolved oxygen (DO) and nutrients for Ouachita River from Columbia Lock and Dam to Jonesville, subsegment 080201. This subsegment was listed on the February 29, 2000 Modified Court Ordered 303(d) List for Louisiana (EPA 2000) as not fully supporting the designated use of propagation of fish and wildlife. The suspected sources and suspected causes for impairment in the 303(d) List are included in Table 1.1. Subsegment 080201 was ranked as priority #2 for TMDL development. The TMDLs in this report were developed in accordance with Section 303(d) of the Federal Clean Water Act and Environmental Protection Agency's (EPA) regulations at 40 CFR 130.7. The 303(d) Listings for other pollutants in this subsegment are being addressed by EPA and the Louisiana Department of Environmental Quality (LDEQ) in other documents.

The purpose of a TMDL is to determine the pollutant loading that a waterbody can assimilate without exceeding the water quality standard for that pollutant and to establish the load reduction that is necessary to meet the standard in a waterbody. The TMDL is the sum of the wasteload allocation (WLA), the load allocation (LA), and a margin of safety (MOS). The WLA is the load allocated to point sources of the pollutant of concern, and the LA is the load allocated to nonpoint sources (NPS). The MOS is a percentage of the TMDL that accounts for the uncertainty associated with the model assumptions, data inadequacies, and future growth.

Table 1.1. Summary of 303(d) Listing of subsegment 080201 (EPA 2000).

Subsegment Number	Waterbody Description	Suspected Sources	Suspected Causes	Priority Ranking (1 = highest)
080201	Ouachita River from Columbia Lock and Dam to Jonesville	Agriculture Unknown Source	Copper Lead Mercury Organic enrichment/low DO Siltation Pesticides Nutrients	2

2.0 STUDY AREA DESCRIPTION

2.1 General Information

Subsegment 080201 is located in northern Louisiana and includes 76 miles of the Ouachita River between Columbia Lock and Dam (approximately 22 miles south of Monroe) and Jonesville (approximately 24 miles west of Natchez, MS; see Figures A.1 and A.2 in Appendix A). The drainage area of the Ouachita River at Columbia Lock and Dam (the upstream end of this subsegment) is 15,677 mi² (USGS 1971). The largest tributary to this subsegment is the Boeuf River, which drains 2,971 mi² (USGS 1971). The flow in the Ouachita River is regulated by many upstream reservoirs and the hydraulics are affected by locks and dams that were built for navigation. During low flows, backwater from the Jonesville Lock and Dam (located approximately 16 miles downstream of this subsegment) extends all the way upstream to the Columbia Lock and Dam. Both of these locks and dams are operated by the Vicksburg District Corps of Engineers.

Although most of the flow in this portion of the Ouachita River is from other subsegments, some of the flow is contributed by the area within the subsegment. This subsegment is approximately 179 mi² in size and is over 60% forested (Table 2.1).

Table 2.1. Land uses in subsegment 080201 based on GAP data (USGS 1998).

Land Use Type	% of Total Area
Fresh Marsh	0.0%
Saline Marsh	0.0%
Wetland Forest	16.2%
Upland Forest	44.6%
Wetland Scrub/Shrub	0.4%
Upland Scrub/Shrub	7.4%
Agricultural	22.8%
Urban	0.0%
Water	8.6%
Barren Land	0.0%
TOTAL	100.0%

2.2 Water Quality Standards

The numeric water quality standards and designated uses for this subsegment are shown in Table 2.2. The primary numeric standard for the TMDLs presented in this report is the DO standard of 5 mg/L year round.

Table 2.2. Water quality standards and designated uses (LDEQ 2000).

Subsegment Number	080201
Waterbody Description	Ouachita River from Columbia Lock and Dam to Jonesville
Designated Uses	ABC
Criteria:	
Chloride	160 mg/L
Sulfate	50 mg/L
DO	5 mg/L (year round)
pH	6.0-8.5
Temperature	33 °C
TDS	400 mg/L

USES: A – primary contact recreation; B – secondary contact recreation; C – propagation of fish and wildlife; D – drinking water supply; E – oyster propagation; F – agriculture; G – outstanding natural resource water; L – limited aquatic life and wildlife use.

For nutrients, there are no specific numeric criteria, but there is a narrative standard that states “The naturally occurring range of nitrogen-phosphorus ratios shall be maintained.... Nutrient concentrations that produce aquatic growth to the extent that it creates a public nuisance or interferes with designated water uses shall not be added to any surface waters.” (LDEQ 2000).

In addition, LDEQ issued a declaratory ruling on April 29, 1996, concerning this language and stated, “That DO directly correlates with overall nutrient impact is a well-established biological and ecological principle. Thus, when the LDEQ maintains and protects DO, the LDEQ is in effect also limiting and controlling nutrient concentrations and impacts.” DO serves as the indicator for the water quality criteria and for assessment of use support. For the TMDLs in this report, the nutrient loading required to maintain the DO standard is the nutrient TMDL.

2.3 Identification of Sources

2.3.1 Point Sources

A listing of all NPDES permits in the Ouachita and Calcasieu River basins was searched to identify any permits within the Ouachita River subsegment (080201). This listing was prepared by EPA Region 6 using databases and permit files from LDEQ. Based on this listing, two NPDES permits were identified within subsegment 080201. Both of these permits were for the Town of Columbia. Both of these discharges were included in the model and TMDL calculations for this subsegment. Their locations are shown in Figures A.2 and A.3 in Appendix A. Other relevant information for these discharges is listed below:

Permit number:	LA0043923	LA0102440
Receiving stream:	Ouachita River	Ouachita River
Flow rate:	0.24 MGD	0.09 MGD
Permit limits:	30 mg/L BOD ₅	10 mg/L BOD ₅

2.3.2 Nonpoint Sources

Agriculture was the only nonpoint source that was cited as a suspected source of impairment in the 303(d) List (Table 1.1).

2.4 Previous Data and Studies

Listed below are previous water quality data and studies in or near the subsegment in the study area. The locations of the water quality monitoring stations are shown on Figure A.2 in Appendix A.

1. Monthly data collected by LDEQ for “Ouachita River at Columbia, LA” (Station 0014) for 1958 to May 1998.
 2. Monthly data collected by LDEQ at “Ouachita River at Harrisonburg, LA” (Station 0085) for March 1978 to July 2001.
 3. Monthly data collected by LDEQ at “Ouachita River at Duty, LA” (Station 0086) for March 1978 to May 1998.
 4. Monthly data collected by LDEQ at “Ouachita River near Jonesville, LA” (Station 0772) for January 1999 to November 1999.
-

5. Intensive survey data collected by Louisiana Department of Natural Resources for the Ouachita River from the Arkansas State Line to the confluence of the Black River and Red River. These surveys were conducted on September 6, 1978 and October 31, 1978 and included 15 stations in subsegment 080201. These surveys include data for temperature, DO, BOD, ammonia nitrogen, and total Kjeldahl nitrogen (TKN).
6. Data collected by USGS at “Ouachita River at Columbia, LA” (Station 07367640) for October 1974 through July 1993 (approximately 150 samples).
7. Data collected by USGS at “Ouachita River near Harrisonburg, LA” (Station 07369340) for October 1958 through July 1979 (8 samples).

3.0 CALIBRATION OF WATER QUALITY MODEL

3.1 Model Setup

In order to evaluate the linkage between pollutant sources and water quality, a computer simulation model was used. The model used for these TMDLs was LA-QUAL (version 4.13), which was selected because it includes the relevant physical, chemical, and biological processes and it has been used successfully in the past for other TMDLs in Louisiana. The LA-QUAL model was set up to simulate organic nitrogen, ammonia nitrogen, nitrate + nitrite nitrogen, ultimate carbonaceous biochemical oxygen demand (CBOD_u), and DO.

The Ouachita River from Columbia Lock and Dam to Jonesville was divided into four reaches to represent varying depths and widths along the stream. The reaches were divided into smaller elements because there will likely be some variation in water quality within each reach. Figure A.3 in Appendix A shows the locations of the reaches and inflows.

3.2 Calibration Period and Calibration Targets

An intensive field survey was not performed for the study area due to schedule and budget limitations. A synoptic survey of the study area was performed by FTN in August 2001, but only limited data were collected during that survey. Routine ambient monitoring data for the subsegment were collected by LDEQ at stations 0014, 0085, 0086, and 0772.

The water quality data for the period of record for these stations were retrieved from the LDEQ website. These data are listed in tabular form in Appendix B. The two conditions that usually characterize critical periods for DO are high temperatures and low flows. High temperatures decrease DO saturation values and increase rates for oxygen demanding processes (BOD decay, nitrification, and sediment oxygen demand (SOD)). In most systems, low flows cause reaeration rates to be lower. The purpose of selecting a critical period for calibration is so that the model will be calibrated as accurately as possible for making projection simulations for critical conditions.

Based on the data in Appendix B, the calibration period was selected as July 15 to August 13, 1991 (Julian day 196 to 225). This period was selected because three of the four LDEQ stations had data for this period and it was a critical period for DO. The calibration targets (i.e., the concentrations to which the model was calibrated) for each parameter were set to the average of the concentrations measured during the calibration period at each of the LDEQ stations. The LDEQ routine monitoring data included DO, total Kjeldahl nitrogen (TKN), nitrate + nitrite, and total organic carbon (TOC) but did not include CBODu or ammonia nitrogen. The CBODu calibration targets were estimated from the TOC data based on statistics from LDEQ's long term BOD analyses. The LDEQ's long term BOD analyses consisted of 140 samples from intensive surveys in the Ouachita River basin during 2001. These samples were analyzed for numerous parameters including CBODu and TOC. The ratio of CBODu to TOC was calculated for each sample and the median of those 140 ratios was determined to be 1.10. Using this result, the CBODu calibration target was estimated as 1.10 times the average TOC during the calibration period. Data from the LDEQ long term BOD analyses are shown in Appendix G.

The calibration targets for ammonia nitrogen and organic nitrogen were estimated using the LDEQ TKN data and ammonia nitrogen and TKN data collected by the USGS at Columbia (07367640) during the calibration period. At the USGS Columbia station (same location as LDEQ station 0014), the ammonia nitrogen target was set to the average of the values measured by the USGS during the calibration period and the organic nitrogen target was set to the average difference between the TKN and ammonia nitrogen values measured during the calibration period. At LDEQ stations 0086 and 0085, the ammonia nitrogen targets were calculated by taking the averages of the TKN values measured by LDEQ and multiplying them by the average ratio of ammonia nitrogen to TKN at the USGS Columbia station during the calibration period. The organic nitrogen targets were then set to the difference between TKN and ammonia. The USGS water quality data for the Columbia station are included in Appendix B.

3.3 Temperature Correction of Kinetics (Data Type 4)

The temperature correction factors used in the model were consistent with the Louisiana Technical Procedures Manual (the "LTP"; LDEQ 2001). These correction factors were:

- Correction for BOD decay: 1.047 (value in LTP is same as model default)
- Correction for SOD: 1.065 (value in LTP is same as model default)
- Correction for ammonia N decay: 1.070 (specified in Data Group 4)
- Correction for organic N decay: 1.020 (not specified in LTP; model default used)
- Correction for reaeration: automatically calculated by the model

3.4 Hydraulics (Data Type 9)

The hydraulics were specified in the input for the LA-QUAL model using the power functions ($\text{width} = a * Q^b + c$ and $\text{depth} = d * Q^e + f$). Widths and depths were estimated from an existing HEC-2 model of the Ouachita and Black Rivers that was obtained from the Vicksburg District Corps of Engineers. HEC-2 is a hydraulic model that calculates depths, widths, velocities, and other parameters. The HEC-2 model was run with the average flow rate during the calibration period and with the downstream boundary set to the average water surface elevation at the Jonesville gage during the calibration period. The output from the HEC-2 model of the Ouachita River from Columbia Lock and Dam to Jonesville is included as Appendix C. Because the water levels during low flow are controlled by the locks and dams, the widths and depths were assumed to be independent of flow. Therefore, the width and depth exponents and coefficients (a, b, d, and e) for each reach were set to zero. The width and depth constants (c and f) were set to the averages of the widths and depths calculated by HEC-2 within each reach. The calculations and plots of the model widths and depths are shown in Appendix D. Input values for the LA-QUAL model are shown in Appendix E.

3.5 Initial Conditions (Data Type 11)

Because temperature is not being simulated in the model, temperature for each reach was specified in the initial conditions for LA-QUAL. The temperature for each reach was set to 30.6°C, the average of temperatures measured at LDEQ stations 0014, 0085, and 0086 during the calibration period. Initial values for DO and ammonia nitrogen were also set to the average of values measured at the three LDEQ stations. The ammonia nitrogen values were estimated from TKN using the same methodology as for the calibration targets (Section 3.2). The input data and sources are shown in Appendix E.

One other parameter that was specified in the initial conditions was chlorophyll. Chlorophyll was not simulated in the model (i.e., it was not “turned on” in Data Group 2), but chlorophyll values were entered as initial conditions and used as a calibration parameter to calibrate the model for DO. The calibration methodology is discussed in Section 3.11.

For other constituents not being simulated, the initial concentrations were set to zero; otherwise, the model would have assumed a fixed concentration of those constituents and the model would have included the effects of the unmodeled constituents on the modeled constituents.

3.6 Water Quality Kinetics (Data Types 12 and 13)

Kinetic rates used in LA-QUAL include reaeration rates, CBOD decay rates, nitrification rates, and mineralization rates (organic nitrogen decay). The values used in the model input are shown in Appendix E.

The O’Connor-Dobbins equation (option 3) was specified for reaeration in the model because it was developed for deep streams like the Ouachita River. However, a minimum surface transfer coefficient (K_L) was also specified in Data Type 3. A minimum K_L was specified because under certain low flow conditions, the velocities in the Ouachita River may be so low that the O’Connor-Dobbins equation would yield a reaeration coefficient less than the minimum value in the LTP (0.7 m/day divided by depth). The minimum K_L was computed based on wind speed because the Ouachita River was considered wide enough that wind-aided reaeration may be significant. Daily wind speeds measured at the Baton Rouge and Shreveport stations were averaged over the calibration period, corrected to a height of 0.1 m, and then used to calculate a wind-aided surface transfer coefficient of 0.94 m/day. Wind data during the calibration period were not available for stations closer to the study area.

The CBOD decay rate was set to 0.07/day, which was the average of seven laboratory decay rates measured during an LDEQ 2001 intensive survey of the Ouachita River from the Arkansas state line to Columbia Lock and Dam (unpublished data). These data are included as Appendix F.

The rate for nitrification (ammonia nitrogen “decay”) was based on median values of laboratory decay rates from LDEQ’s long term BOD analyses. The LDEQ long term BOD analyses consisted of 140 samples from intensive surveys in the Ouachita River basin during 2001. The median decay rate for nitrogenous biochemical oxygen demand (NBOD) was approximately 0.07/day. These data are shown in Appendix G. Because instream decay rates are typically slightly higher than laboratory decay rates, the nitrification rate was set to 0.10/day for all reaches.

The mineralization rates (organic nitrogen decay) in the model were set to 0.02/day for all reaches. This value was similar to the values shown in Table 5.3 of the “Rates, Constants, and Kinetics” publication (EPA 1985) for dissolved organic nitrogen being transformed to ammonia nitrogen. The literature values for mineralization rates are shown in Appendix H.

One other input value was specified for characterizing the nitrification process. In the program constants section of the model input file (data type 3), the nitrification inhibition option was set to 1 instead of the default of option number 2. With the default option, the nitrification rate drops rapidly when the DO drops below 2 mg/L, which results in an unrealistic build up of ammonia nitrogen at low DO. Option number 1 provides nitrification inhibition that is similar to what is used in other water quality models such as QUAL2E and WASP (see Figure 3.5 in FTN 2000).

3.7 Nonpoint Source Loads (Data Type 19)

The NPS loads that are specified in the model can be most easily understood as resuspended load from the bottom sediments and are modeled as SOD, benthic ammonia source rates, CBODu loads, and organic nitrogen loads. The SOD (specified in data type 12), the benthic ammonia source rates (specified in data type 13), and the mass loads of organic nitrogen and CBODu (specified in data type 19) were all treated as calibration parameters; their values were adjusted until the model output was similar to the calibration target values. The procedures used for calibrating the model are discussed in Section 3.11. The values used as model input are shown in Appendix E.

3.8 Headwater, Tributary, and Incremental Flow Rates (Data Types 16, 20, and 24)

The inflow rate for the Ouachita River (headwater) was based on the average flow measured by the Corps of Engineers for the Ouachita River at Monroe, LA (Station 91) during the calibration period (July 15 to August 13, 1991). Although there was a USGS gaging station on the Ouachita River at Columbia Lock and Dam, it was discontinued in 1987. The average flow for the Monroe station was multiplied by the ratio of the drainage areas at Columbia Lock and Dam and Monroe to estimate the flow at the upstream end of the model (Columbia Lock and Dam). These data and calculations are shown in Appendix I.

The inflow rate for the Beouf River was based on the flow measured by the USGS for the Beouf River at Girard, LA (07368000) and Bayou LaFourche near Crew Lake, LA (07369000). Bayou LaFourche flows into the Beouf River downstream of the Girard gage. Therefore, the combined flow from both streams was used to estimate flow at the mouth of the Beouf River. Flow per square mile was estimated by dividing the sum of the averages of the measured flows for the two stations by the sum of the reported drainage areas for the two stations. The total flow per square mile was multiplied by the drainage area for the Beouf River at the mouth (USGS 1971) to estimate model input values for the Beouf River inflow to the Ouachita River. These data and calculations are shown in Appendix I.

For the incremental inflow and Rawson Creek inflow, a flow per square mile was calculated for small wooded drainage areas using flow data for 1991 at USGS stations on Big Creek at Pollock, LA (07373000) and Hemphill Creek at Nebo, LA (07373250). Average flows for the calibration period were divided by the drainage area. The flow per square mile values calculated this way were very similar (0.023 for Hemphill Creek and 0.025 for Big Creek). The average of these values was used to estimate the tributary and incremental inflows.

The drainage area for Rawson Creek (USGS 1971) was used to estimate Rawson Creek flow. Drainage areas for the model reaches were estimated and used to estimate the incremental inflow for each reach. These reach drainage areas were estimated by subtracting drainage areas reported by the USGS at intervals along the Ouachita River to determine the intervening drainage

area. The inflows used in the model are shown in Appendix E. Data used in the calculations described above are included as Appendix I.

3.9 Headwater, Tributary and Incremental Inflow Water Quality (Data Types 16, 17, 20, 21, 24 and 25)

Concentrations of DO, CBODu, organic nitrogen, ammonia nitrogen, and nitrate + nitrite nitrogen were specified in the model for the headwater, tributary, and incremental inflows. Water quality for these inflows was based on average concentrations from July and August 1991 that were measured at LDEQ and USGS stations.

For the headwater water quality, DO and nitrate + nitrite nitrogen were set to the averages of measurements at the LDEQ station at Monroe (0067). The average TOC measurement at this station was used to estimate CBODu using the same ratio of CBODu to TOC as used for the calibration targets (Section 3.2). The average TKN at Station 0067 value was used to estimate ammonia nitrogen and organic nitrogen using the same ratio of ammonia to TKN as used for the calibration targets (Section 3.2).

Beouf River water quality was based on measurements at the LDEQ and USGS stations near Fort Necessity (LDEQ 0016, USGS 07369150). DO and nitrate + nitrite nitrogen were set to the average of measurements from the LDEQ station. CBODu was estimated from the average TOC measurement at the LDEQ station. Ammonia nitrogen was set to the August 15, 1991 measurement at the USGS station. Organic nitrogen was estimated as the average TKN value measured by the USGS at that station minus ammonia nitrogen. Beouf River water quality was also used for Rawson Creek.

Water quality for incremental inflows was based on average concentrations from July and August 1991 that were measured at LDEQ stations representing inflows from forested areas (reaches 1 – 3) and agricultural areas (reach 4). The stations used to develop water quality concentrations for forested areas were:

LDEQ Station Number	Waterbody Name
0015	Little Cornie Bayou east of Lillie, Louisiana

0078	Dugdemonia River near Hodge, Louisiana
0325	Middle Fork Bayou D'Arbonne west of Farmerville, Louisiana
0332	Castor Creek west of Columbia, Louisiana

The stations used to develop water quality concentrations for agricultural areas were:

LDEQ Station Number	Waterbody Name
0130	Turkey Creek Cutoff at Baskin, LA
0066	Tensas River at Tendal, Louisiana
0328	Big Creek east of Rayville, Louisiana

The data used in the calculations of water quality inputs described above are included as Appendix J. Model inputs are shown in Appendix E.

3.10 Point Source Inputs (Data Types 24 and 25)

Two NPDES point source discharges from the Town of Columbia STP were included in the model. Discharge monitoring report (DMR) data for the calibration period in 1991 were not available. Therefore, the flow and water quality inputs for the point sources were taken from their permits. The flow rates for the point sources were set to their design flows. BOD is the only water quality parameter modeled that had permit limits at the two point sources. The CBOD_u inputs for the point sources were set to the monthly average permit limits for BOD₅ multiplied by 2.3 to convert the BOD₅ to CBOD_u. DO, ammonia nitrogen, and organic nitrogen concentrations were set based on the BOD₅ permit limits and guidance in the LTP. Nitrate + nitrite input concentrations for the point sources set to the EPA drinking water criterion for nitrate (10 mg/L). Model input values are shown in Appendix E.

3.11 Calibration Methodology

The model was calibrated by adjusting 5 input parameter: organic nitrogen loads, benthic ammonia source rates, CBOD_u mass loads, SOD, and the chlorophyll concentration. First, the organic nitrogen loads were adjusted until the predicted organic nitrogen concentrations were similar to the observed concentrations. Organic nitrogen was calibrated first because none of the

other state variables (DO, CBODu, ammonia nitrogen) will affect the organic nitrogen concentrations. Next, the benthic ammonia source rates were adjusted until the predicted ammonia nitrogen concentrations were similar to the observed concentrations. Then the CBODu loads were adjusted until the predicted CBODu concentrations were similar to the observed concentrations.

After the organic nitrogen, ammonia nitrogen, and CBODu were calibrated, an attempt was made to calibrate the DO by adjusting the SOD. However, the predicted DO was lower than the calibration target even after reducing the SOD to zero. Therefore, chlorophyll concentrations were specified in the initial conditions to account for the effects of algae on DO. This was considered reasonable because most large streams in Louisiana have significant algal productivity.

Because no chlorophyll data were available for the Ouachita River, the chlorophyll concentrations were used as a calibration parameter. The SOD was set to $0.5 \text{ g/m}^2/\text{day}$, which was considered to be a reasonable value for the Ouachita River. Then the chlorophyll concentrations were adjusted until the predicted DO concentrations were similar to the calibration targets for DO. Because adding the chlorophyll increased the “effective CBODu” concentration in the model, the CBODu mass loads were then reduced until the predicted “effective CBODu” concentrations were similar to the calibration targets for CBODu. Then the DO calibration was refined again by adjusting the chlorophyll slightly. This iteration of fine turning the CBODu mass loads and the chlorophyll concentrations was repeated several times until a close match between predicted and observed values was achieved for both the CBODu and DO.

The reason that the chlorophyll affects the predicted “effective CBODu” concentration in the model is that the model assumes that a measured CBODu concentration will include oxygen demand from algal respiration and death in addition to oxygen demand from decay of dissolved substances in the water. The model provides a coefficient in Data Type 3 to account for this effect. This coefficient was set to $0.175 \text{ mg/L of BOD per } \mu\text{g/L of chlorophyll}$, which was the midpoint of the range recommended in the LA-Qual User’s Manual.

3.12 Model Results for Calibration

Plots of predicted and observed water quality for the calibration are presented in Appendix K and a printout of the LA-QUAL output file is included as Appendix L. The calibration was considered to be acceptable based on the amount of data that were available.

4.0 WATER QUALITY MODEL PROJECTION

EPA's regulations at 40 CFR 130.7 require the determination of TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. Therefore, the calibrated model was used to project water quality for critical conditions. The identification of critical conditions and the model input data used for critical conditions are discussed below.

4.1 Identification of Critical Conditions

Section 303(d) of the Federal Clean Water Act and EPA's regulations at 40 CFR 130.7 both require the consideration of seasonal variation of conditions affecting the constituent of concern and the inclusion of a MOS in the development of a TMDL. For the TMDLs in this report, analyses of LDEQ long-term ambient data were used to determine critical seasonal conditions. A combination of implicit and explicit MOS was used in developing the projection model.

Critical conditions for DO have been determined for Louisiana waterbodies in previous TMDL studies. The analyses concluded that the critical conditions for stream DO concentrations occur during periods with negligible nonpoint runoff, low stream flow, and high stream temperature.

When the rainfall runoff (and nonpoint loading) and stream flow are high, turbulence is higher due to the higher flow and the stream temperature is lowered by the cooler precipitation and runoff. In addition, runoff coefficients are higher in cooler weather due to reduced evaporation and evapotranspiration, so that the high flow periods of the year tend to be the cooler periods. DO saturation values are, of course, much higher when water temperatures are cooler, but BOD decay rates are much lower. For these reasons, periods of high loading are periods of higher reaeration and DO but not necessarily periods of high BOD decay.

LDEQ interprets this phenomenon in its TMDL modeling by assuming that the annual nonpoint loading, rather than loading for any particular day, is responsible for the accumulated benthic blanket of the stream, which is, in turn, expressed as SOD and/or resuspended BOD in

the model. This accumulated loading has its greatest impact on the stream during periods of higher temperature and lower flow.

According to the LTP, critical summer conditions in DO TMDL projection modeling are simulated by using the annual 7Q10 flow or 0.1 cfs, whichever is higher, for all headwaters, and 90th percentile temperature for the summer season. Model loading is from point sources, perennial tributaries, SOD, and resuspension of sediments.

In reality, the highest temperatures occur in July-August and the lowest stream flows occur in October-November. The combination of these conditions plus the impact of other conservative assumptions regarding rates and loadings yields an implicit MOS that is not quantified. Over and above this implicit MOS, an explicit MOS of 10% for NPS was incorporated into the TMDLs in this report to account for model uncertainty.

4.2 Temperature Inputs

The LTP (LDEQ 2000b) specifies that the critical temperature should be determined by calculating the 90th percentile seasonal temperature for the waterbody being modeled. Long term temperature data from the Ouachita River at Duty, Louisiana (LDEQ station 0086) and the Ouachita River at Harrisonburg, Louisiana (LDEQ station 0085) were used to calculate a 90th percentile summer temperature. The average of the 90th percentile temperatures at the two LDEQ stations was 30.4EC. The 90th percentile temperature calculations are included as Appendix M. This value was specified in Data Type 11 in the model and is shown in Appendix N.

Because the Ouachita River from Columbia Lock and Dam to Jonesville has a year round standard for DO, a winter projection simulation was not performed. As discussed above, the most critical time of year for meeting a constant DO standard is the period of high temperatures and low flows (i.e., summer).

4.3 Headwater, Tributary, and Incremental Inputs

The inputs for the headwaters and tributaries for the projection simulation were based on guidance in the LTP. As specified in the LTP, the DO concentration for the headwater and

tributary inflow was set to 90% saturation at the critical temperature. Headwater and tributary concentrations for other parameters were set to calibration values.

The USGS flow gage on the Ouachita River at Monroe (07367000) has a 7Q10 flow of 273 cfs (Lee 2000). The LTP specifies that the critical flow rate for summer should be set to the 7Q10 flow or 0.1 cfs, whichever is higher. Therefore, the headwater flow rate in the projection simulation was set to 273 cfs (7.76 m³/sec). The 7Q10 flow for the Beouf River at its mouth was set to the sum of the 7Q10 flows for Bayou LaFourche near Crew Lake, Louisiana (07369000) and Beouf River near Girard, Louisiana (07368000) as reported by USGS (1980). The sum was 15.1 cfs (0.43 m³/sec). Incremental inflow and Rawson Creek inflow were set to zero in the projection simulation based on the small drainage areas that they represent. The values used as model input in the projection simulation are shown in Appendix N. The published 7Q10 information is shown in Appendix O.

4.4 Point Source Inputs

Flows for the two point sources in the projection run were set to 1.25 times the design flow in order to incorporate an explicit 20% MOS. Water quality was based on current permit limits (the same as for the calibration run). No load reductions were imposed on either facility during the projection. The values used as model input in the projection simulation are shown in Appendix N.

4.5 Nonpoint Source Loads

Because the initial projection simulation was showing low DO values in all of the reaches, the NPS loadings were reduced until all of the predicted DO values were equal to or greater than the water quality standard of 5.0 mg/L. The same percent reduction was applied to all components of the NPS loads used to calibrate the model (benthic ammonia source rates and mass loads of CBOD_u and ammonia nitrogen) in all of the reaches. The values used as model input in the projection simulation are shown in Appendix N.

4.6 Other Inputs

The only model inputs that were changed from the calibration to the projection simulation were the inputs discussed above in Sections 4.2 – 4.5. Other model inputs (e.g., hydraulics, decay rates, reaeration equations, etc.) were unchanged from the calibration simulation.

4.7 Model Results for Projection

Plots of predicted water quality for the projection are presented in Appendix P and a printout of the LA-QUAL output file is included as Appendix Q.

A NPS load reduction of approximately 49% for all reaches was required to bring the predicted DO values to at least 5.0 mg/L. This percent reduction for NPS loads represents a percentage of the entire NPS loading, not a percentage of the manmade NPS loading. The NPS loads in this report were not divided between natural and manmade because it would be difficult to estimate natural NPS loads for the study area. No reductions were made to the point source discharges because the lowest predicted DO values occurred approximately 80 km downstream of the two discharges.

5.0 TMDL CALCULATIONS

5.1 DO TMDL

A total maximum daily load (TMDL) for DO has been calculated for the Ouachita River from Columbia Lock and Dam to Jonesville subsegment based on the results of the projection simulation. The DO TMDLs are presented as oxygen demand from CBOD_u, organic nitrogen, ammonia nitrogen, and SOD. A summary of the loads for Ouachita River from Columbia Lock and Dam to Jonesville is presented in Table 5.1.

The TMDL calculations were performed using FORTRAN program that was written by FTN personnel. This program reads two files; one is the LA-QUAL output file from the projection simulation and the other is a small file with miscellaneous information needed for the TMDL calculations (shown in Appendix R). The output from the program is shown in Appendix S and the source code for the program is shown in Appendix T.

Table 5.1. DO TMDL for Subsegment 080201 (Ouachita River from Columbia Lock and Dam to Jonesville).

	Oxygen demand (kg/day) from:				Total oxygen demand (kg/day)
	CBOD _u	Organic N	Ammonia N	SOD	
WLA for LA0102440	7.95	7.48	14.96	na	30.39
WLA for LA0043923	59.62	112.23	56.12	na	227.97
MOS for all point sources	16.89	29.93	17.77	na	64.59
LA for nonpoint sources	50940.38	8870.11	1674.99	7514.89	69000.37
MOS for nonpoint sources	5660.04	985.57	186.11	834.99	7666.71
Total maximum daily load	56684.88	10005.32	1949.95	8349.88	76990.03

The oxygen demand from organic nitrogen and ammonia nitrogen was calculated as 4.33 times the nitrogen loads (assuming that all organic nitrogen is eventually converted to ammonia). The value of 4.33 is the same ratio of oxygen demand to nitrogen that is used by the LA-QUAL

model. For the SOD loads, a temperature correction factor was included in the calculations (in order to be consistent with LDEQ procedures).

5.2 Nutrient TMDL

As discussed in Section 2.2, Louisiana has no numeric standards for nutrients, but has a narrative standard that states that “the naturally occurring range of nitrogen-phosphorus ratios shall be maintained” (LDEQ 2000). For this TMDL, nutrients were defined as total nitrogen (ammonia nitrogen plus organic nitrogen plus nitrate/nitrite nitrogen) and total phosphorus. The value used for the naturally occurring nitrogen to phosphorus ratio was 8.0. This ratio was based on LDEQ reference stream data for the Upper Mississippi Alluvial Plain and South Central Plain ecoregions (Smythe 1999). These data are shown in Appendix U.

The first step in calculating the nutrient TMDL was to determine the loads of total nitrogen (TN) that were simulated in the projection model. The loads in the projection model represent the maximum allowable loads that will maintain DO standards. Then the allowable loads of total phosphorus (TP) were calculated by dividing the nitrogen loads by the naturally occurring ratio of TN to TP. The resulting loads of TN and TP for the Ouachita River subsegment are presented in Table 5.2.

Table 5.2. Nutrient TMDL for Subsegment 080201 (Ouachita River from Columbia Lock and Dam to Jonesville).

	Organic N (kg/day)	Ammonia N (kg/day)	NO₂ + NO₃ N (kg/day)	Total N (kg/day)	Total Phosphorus (kg/day)
WLA for LA102440	1.73	3.46	3.46	8.64	0.88
WLA for LA439230	25.92	12.96	8.64	47.52	4.85
MOS for all point sources	6.91	4.10	3.02	14.04	1.43
LA for NPS	2048.52	79.43	123.33	2251.28	229.72
MOS for NPS	227.61	8.83	13.70	250.14	25.52
Total Maximum Daily Load	1310.69	108.78	152.15	2571.62	262.40

5.3 Ammonia Toxicity

Although subsegment 080201 is not on a 303(d) List for ammonia, the ammonia concentrations predicted by the projection model were checked to make sure that they did not

exceed EPA criteria for ammonia toxicity (EPA 1999). The EPA criteria are dependent on temperature and pH. The water temperature used to calculate the ammonia toxicity criterion for Ouachita River was the same as the critical temperature used in the projection simulation (30.4°C). For pH, an average of the values measured at the LDEQ stations during the calibration period was used. The resulting criterion was 2.4 mg/L of ammonia nitrogen. The instream ammonia nitrogen concentrations predicted by the LA-QUAL model (=0.2 mg/L) were well below the criterion. This indicates that the ammonia nitrogen loadings that will maintain the DO standard are low enough that the EPA ammonia toxicity criteria will not be exceeded under critical conditions. the ammonia toxicity calculations are shown in Appendix V.

5.4 Summary of Source Reductions

In summary, the projection modeling used to develop the TMDLs above showed that NPS loads need to be reduced by approximately 49% along Ouachita River from Columbia Lock and Dam to Jonesville to maintain the DO standard. No changes needed to be made to the point source permit limits.

5.5 Seasonal Variation

As discussed in Section 4.1, critical conditions for DO in Louisiana waterbodies have been determined to be when there is negligible nonpoint runoff and low stream flow combined with high water temperatures. In addition, the model accounts for loadings that occur at higher flows by modeling sediment oxygen demand. Oxygen demanding pollutants that enter the waterbodies during higher flows settle to the bottom and then exert the greatest oxygen demand during the high temperature seasons.

5.6 Margin of Safety

The MOS accounts for any lack of knowledge or uncertainty concerning the relationship between load allocations and water quality. As discussed in Section 4.1, the highest temperatures occur in July through August, the lowest stream flows occur in October through November, and the maximum point source discharge occurs following a significant rainfall, i.e., high-flow

conditions. The combination of these conditions, in addition to other conservative assumptions regarding rates and loadings, yields an implicit MOS which is not quantified. In addition to the implicit MOS, the TMDLs in this report include explicit MOS of 10% for NPS loads and 20% for point source loads.

6.0 SENSITIVITY ANALYSES

All modeling studies necessarily involve uncertainty and some degree of approximation. It is therefore of value to consider the sensitivity of the model output to changes in model coefficients, and in the hypothesized relationships among the parameters of the model. The sensitivity analyses were performed by allowing the LA-QUAL model to vary one input parameter at a time while holding all other parameters to their original value. The calibration simulation was used as the baseline for the sensitivity analysis. The percent change of the model's minimum DO projections to each parameter is presented in Table 6.1. Each parameter was varied by "30%, except for temperature, which was varied "2°C.

Values reported in Table 6.1 are sorted by percentage variation of minimum DO from smallest percentage variation to largest. The parameters to which DO was most sensitive were reaeration, BOD decay rate, wasteload BOD, headwater flow, temperature, and depth.

Table 6.1. Summary of results of sensitivity analyses.

Input Parameter	Parameter Change	Predicted minimum DO (mg/L)	Percent Change in Predicted DO (%)
Baseline	-	2.22	N/A
Wasteload flow	+30%	2.21	0
Wasteload Organic N	-30%	2.25	1
Wasteload Organic N	+30%	2.20	1
Wasteload flow	-30%	2.26	2
Wasteload NH ₃	-30%	2.26	2
Wasteload NH ₃	+30%	2.19	2
Ammonia decay rate	+30%	2.17	2
Ammonia decay rate	-30%	2.30	4
Organic N Decay Rate	+30%	2.14	4
Stream Depth	+30%	2.13	4
Organic N Decay Rate	-30%	2.32	5
Benthal Demand	-30%	2.42	9
Benthal Demand	+30%	2.03	9
Wasteload DO	-30%	2.03	9
Wasteload DO	+30%	2.42	9
Initial Temperature	+2EC	1.99	10
Initial Temperature	-2EC	2.48	11
Headwater flow	+30%	2.50	12
Headwater flow	-30%	1.95	12
Wasteload BOD	+30%	1.89	15
BOD decay rate	+30%	1.87	16
Stream Depth	-30%	2.58	16
Wasteload BOD	-30%	2.61	18
BOD decay rate	-30%	2.91	31
Stream Reaeration	-30%	1.50	33
Stream Reaeration	+30%	3.03	36

7.0 OTHER RELEVANT INFORMATION

This TMDL has been developed to be consistent with the antidegradation policy in the LDEQ water quality standards (LAC 33:IX.1109.A).

Although not required by this TMDL, LDEQ utilizes funds under Section 106 of the Federal Clean Water Act and under the authority of the Louisiana Environmental Quality Act to operate an established program for monitoring the quality of the state's surface waters. The LDEQ Surveillance Section collects surface water samples at various locations, utilizing appropriate sampling methods and procedures for ensuring the quality of the data collected. The objectives of the surface water monitoring program are to determine the quality of the state's surface waters, to develop a long-term data base for water quality trend analysis, and to monitor the effectiveness of pollution controls. The data obtained through the surface water monitoring program is used to develop the state's biennial 305(b) report (Water Quality Inventory) and the 303(d) List of impaired waters. This information is also utilized in establishing priorities for the LDEQ NPS program.

The LDEQ has implemented a watershed approach to surface water quality monitoring. Through this approach, the entire state is sampled over a five-year cycle with two targeted basins sampled each year. Long-term trend monitoring sites at various locations on the larger rivers and Lake Pontchartrain are sampled throughout the five-year cycle. Sampling is conducted on a monthly basis or more frequently if necessary to yield at least 12 samples per site each year. Sampling sites are located where they are considered to be representative of the waterbody. Under the current monitoring schedule, targeted basins follow the TMDL priorities. In this manner, the first TMDLs will have been implemented by the time the first priority basins will be monitored again in the second five-year cycle. This will allow the LDEQ to determine whether there has been any improvement in water quality following establishment of the TMDLs. As the monitoring results are evaluated at the end of each year, waterbodies may be added to or removed from the 303(d) List. The sampling schedule for the first five-year cycle is shown below. The Ouachita River Basin will be sampled again in 2004.

1998 – Mermentau and Vermilion-Teche River Basins
1999 – Calcasieu and Ouachita River Basins
2000 – Barataria and Terrebonne Basins
2001 – Lake Pontchartrain Basin and Pearl River Basin
2002 – Red and Sabine River Basins

(Atchafalaya and Mississippi Rivers will be sampled continuously.)

In addition to ambient water quality sampling in the priority basins, the LDEQ has increased compliance monitoring in those basins, following the same schedule. Approximately 1,000 to 1,100 permitted facilities in the priority basins were targeted for inspections. The goal set by LDEQ was to inspect all of those facilities on the list and to sample 1/3 of the minors and 1/3 of the majors.

8.0 PUBLIC PARTICIPATION

When EPA establishes a TMDL, 40 CFR §130.7(d)(2) requires EPA to publicly notice and seek comment concerning the TMDL. Pursuant to an October 1, 1999 Court Order, this TMDL was prepared under contract to EPA. After development of the draft of this TMDL, EPA commenced preparation of a notice seeking comments, information, and data from the general and affected public. Comments and additional information were submitted during the public comment period and this TMDL was revised accordingly. Responses to these comments and additional information are included in Appendix W. EPA has transmitted this revised TMDL to LDEQ for incorporation into LDEQ's current water quality management plan.

9.0 REFERENCES

- EPA. 1985. Rates, Constants, and Kinetics Formulations in Surface Water Quality Modeling (Second Edition). Written by G.L. Bowie et. al. EPA/600/3-85/040. U.S. Environmental Protection Agency, Environmental Research Laboratory, Athens, GA.
- EPA. 1999. 1999 Update of Ambient Water Quality Criteria for Ammonia. EPA-822-R-99-014. U.S. Environmental Protection Agency, Office of Water. December, 1999.
- EPA. 2000. Modified Court Ordered 303(d) List for Louisiana. Downloaded from EPA Region 6 website (www.epa.gov/earth1r6/6wq/ecopro/latmdl/modifiedcourtdorderedlist.xls).
- FTN. 2000. Bayou Lacassine Watershed TMDL for Dissolved Oxygen. Prepared for LDEQ by FTN Associates, Ltd., Little Rock, AR: September 2000.
- LDEQ. 1998. 1998 305 (b) Appendix C Table. Printed from Louisiana Department of Environment Quality website (www.deq.state.la.us/planning/305b/1998/305b-ctab.htm).
- LDEQ. 2000. Environment Regulatory Code. Part IX. Water Quality Regulations. Chapter 11. Surface Water Quality Standards. § 1123. Numerical Criteria and Designated Uses. Printed from LDEQ website (www.deq.state.la.us/planning/regs/title33/index.htm).
- LDEQ. 2001. Louisiana TMDL Technical Procedures Manual. Developed by M.G. Waldon and revised by R.K. Duerr, and M.U. Aguiard. Engineering Group 2, Louisiana Department of Environmental Quality, Baton Rouge, LA: September 8, 2000.
- Lee, F.N. 2000. Low-Flow on Streams in Louisiana. Report prepared for LDEQ. March 2000.
- Smythe, E. deEtte. 1999. Overview of the 1995 and 1996 Reference Streams. Prepared for Engineering 2 Section, Environmental Technology Division, Louisiana Department of Environmental Quality, Baton Rouge, LA: June 28, 1999.
- USGS. 1971. Drainage Area of Louisiana Streams. Basic Records Report No. 6. Prepared by US Geological Survey in cooperation with Louisiana Department of Transportation and Development Baton Rouge, LA: 1971 (Reprinted 1991).
- USGS. 1980. Low-Flow Characteristics of Louisiana Streams. Water Resources Technical Report No. 22. Prepared by US Geological Survey in cooperation with Louisiana Department of Transportation and Development, Baton Rouge, LA.

USGS. 1998. Louisiana GAP Land Use/Land Cover Data. Downloaded from Spatial Data and Metadata Server, National Wetlands Research Center, U.S. Geological Survey. (<http://sdms.nwrc.gov/gap/landuse.html>).

Wiland, B.L., and K. LeBlanc. 2001. LA-QUAL for Windows User's Manual, Model Version 3.02, Manual Revision B. Wiland Consulting, Inc. and Louisiana Department of Environmental Quality. March 7, 2001.

**APPENDIX A THROUGH V AVAILABLE
THROUGH EPA UPON REQUEST**

APPENDIX W

Responses to Comments

COMMENTS AND RESPONSES
OUACHITA RIVER TMDLs FOR DO AND NUTRIENTS
May 28, 2002

EPA appreciates all comments concerning these TMDLs. Comments that were received are shown below with EPA responses or notes inserted in a different font.

GENERAL COMMENTS FROM LOUISIANA DEPARTMENT OF ENVIRONMENTAL QUALITY (LDEQ):

Note: LDEQ submitted one document containing comments on 98 TMDLs for various pollutants and subsegments throughout the Ouachita and Calcasieu basins. Only the portions of that comment document that apply to the DO and nutrient TMDLs in the Ouachita basin (10 subsegments) are shown below. Some of the general comments may not apply to this report.

The Louisiana Department of Environmental Quality hereby submits comments on the 98 TMDLs and the calculations for these TMDLs prepared by EPA Region 6 for waters listed in the Calcasieu and Ouachita river basins, under section 303(d) of the Clean Water Act. Listed below are general comments.

1. Many of these TMDLs are based on models using historical water quality data gathered at a single or small number of locations rather than survey data gathered at sites spaced throughout the waterbody. The hydraulic information used was generally an average value or estimated value, not taken at the same time as the water quality data. The calibrations are inadequate due to the lack of appropriate hydrologic data and the paucity of water quality data. The resulting TMDLs are invalid. LDEQ does not accept these TMDLs.

Response: The TMDLs were based on existing data plus information that could be obtained with available resources. Each model was developed using the most appropriate hydraulic information and water quality data that were available. A rationale was provided for data use and assumptions and limitations were given. Although LDEQ typically collects more data for model calibration than what was available for calibration of most of these models, EPA considers these model calibrations and the resulting TMDLs to be valid.

2. LDEQ does not consider any of these waters to be impaired due to low dissolved oxygen, nutrients, or ammonia. Many of these waters simply have inappropriate standards and criteria. The resources spent on developing these TMDLs could have been far more effectively and wisely spent on reviewing, approving, and assisting in the development of appropriate standards and criteria for these waters through the UAA process.

Response: TMDLs were developed for these subsegments based on the requirements of Section 303(d) of the Clean Water Act and regulations at 40 CFR 130.7 and the suspected causes of impairment (organic enrichment/low DO and/or nutrients) for each subsegment in the EPA Modified Court Ordered 303(d) List. TMDLs must be established to meet existing water quality standards. If it is determined that a standards changes is appropriate, the TMDL can be revised to reflect that change.

3. CBODu and NH₃-N were estimated from surrogate parameters rather than actual measured data for most of the TMDLs. The TMDL report uses the LDEQ's multi-basin loading database's median ratio values between the ultimate loads and the proposed surrogates. This data was based on the measured data from the last two years of LDEQ water quality surveys. LDEQ objects to the correlation of TOC to CBOD and NH₃-N to TKN unless these correlations are taken from water quality data on the modeled waterbody. Our studies have shown only a moderate correlation between these parameters within the same waterbody, however when this correlation was attempted across waterbodies, extreme variability was seen and the correlations were not judged valid. It is possible that a combination of surrogates will obtain a better correlation, such as TOC along with color, turbidity, pH, etc. LDEQ is currently researching these options.

Response: EPA agrees that it would be ideal to have data collected from each modeled waterbody for relating TOC to CBOD and NH₃-N to TKN. However, none of these subsegments had sufficient data from which these relationships could be developed. Relationships with surrogate parameters were used only when data for the desired parameter was not available.

4. BOD decay rates were estimated from surrogate parameters rather than actual measured data for most of the TMDLs. The TMDL report uses the LDEQ's multi-basin loading database's median values. This data was based on the measured data from the last two years of LDEQ water quality surveys. It has been LDEQ's experience that these rates vary significantly from waterbody to waterbody and frequently vary significantly within the same waterbody. LDEQ objects to using surrogate data without regard for specific waterbody conditions for these parameters.

Response: Due to the schedule and level of resources available for this project, it was not feasible to perform long term BOD time series analyses on samples from these waterbodies. Given this situation, using LDEQ's database was considered the best approach for estimating decay rates.

5. A winter projection model was not developed for most of the TMDLs. Winter projection models must be developed to address seasonality requirements of the Clean Water Act. Where point sources have seasonally variable effluent limitations or such seasonal variations are proposed, a winter projection model is required to show that standards are met year-round.

Response: As discussed in Section 4.2 of each report, summer is the most critical season for meeting the year round standard for DO for these subsegments. Therefore, the summer simulation satisfies the seasonality requirements of the Clean Water Act. The available information for point source discharges indicated that the facilities discharging to these waterbodies do not have seasonal permit limits. If any of these facilities wishes to pursue seasonal permit limits, then LDEQ or the permittee can re-run the model to develop seasonal wasteload allocations.

6. LDEQ takes exception to the calculation of a TMDL based on TN/TP ratios derived from waterbodies other than the modeled waterbody. It is LDEQ's experience that the natural allowable TN/TP ratio is waterbody-specific and can vary dramatically between streams.

Response: These nutrient TMDLs were developed using naturally occurring ratios of nitrogen to phosphorus based on Louisiana's narrative water quality standard for nutrients. These ratios were calculated using reference stream data rather than long term monitoring data for each subsegment because the reference stream data were considered to be more appropriate for naturally occurring conditions.

7. LDEQ has not adopted the EPA recommended ammonia criteria (1999) and takes exception to its use in these TMDLs. In general, LDEQ does not accept EPA's use of national guidance for TMDL endpoints. The nationally recommended criteria do not consider regional or site-specific conditions or species and may be inappropriately over protective or under protective. No ammonia nitrogen toxicity has been demonstrated or documented in any of the waterbodies in these TMDLs. The general criteria (in particular, LAC 33:IX.1113.B.5) require state waters be free from the effects of toxic substances.

Response: Ammonia toxicity calculations were performed to ensure that the ammonia loadings that will maintain DO standards will not cause any exceedences of the ammonia toxicity criteria. National guidance for ammonia toxicity was used in the absence of any numerical state water quality standards for ammonia. EPA believes that this evaluation offers assurances that waters will continue to be free from the effects of toxic substances.

8. Algae were not simulated. Was there evidence that algae did not have an impact on the waterbody? Did the contractor have any Chlorophyll a measurements on which to base this determination?

Response: For most of these subsegments, the effects of algae were not simulated in the models because there were no data to clearly demonstrate a need for including algae and the models calibrated well without including algae (i.e., the

models were calibrated without having to use unreasonable coefficients to compensate for algal effects).

SPECIFIC COMMENTS FROM LDEQ FOR OUACHITA RIVER:

1. The hydraulic data derived from the HEC-2 model is suspect due to the large variance between the calibration/projection flow rates and the flow rate used in the hydraulic model.

Response: The HEC-2 model has been re-run with the same flows as in the LA-QUAL calibration run. The resulting depths and widths have been input into LA-QUAL. Because the new widths and depths were similar to the previous values, none of the calibration parameters needed to be changed in LA-QUAL.

2. The incorrect flow station was used to determine the calibration and critical flows. The 7Q10 used does not coincide with the LDEQ determined value at this location.

Response: The calibration flow was determined using the only available gages with flow data during the calibration period. The 7Q10 flow used for the headwater in the projection was the published value based on 28 years of data for the Ouachita River at Monroe (07367000). The only other USGS gage on the Ouachita River in Louisiana with a 7Q10 published in Lee (2000) was the Columbia L&D gage, but that 7Q10 was based on only 11 years of data, which is considered insufficient for calculating a 7Q10. There are no significant tributaries entering the Ouachita River between the Monroe gage and the upstream end of this model.

Reference: Lee, F.N. 2000. Low-Flow on Streams in Louisiana. Report prepared for LDEQ. March 2000.

3. LDEQ takes exception to the method for determining the organic nitrogen load used for the point sources.

Response: The point source organic nitrogen loads were assumed to be half of the ammonia loads for mechanical treatment systems and twice the ammonia loads for pond treatment systems. These assumptions have been used in previous TMDLs approved by LDEQ.

4. The Fortran program used by the contractor does not adequately show the methodology used in determining the percent reduction based on the projection loading. From the information that is given, LDEQ believes that the chosen method is contrary to the current method in use by the Department.

Response: The percent reductions were calculated by subtracting the projection input value from the calibration input value and then dividing by the calibration input value. This procedure is slightly different than what LDEQ uses but still provides percent reductions that are useful. These calculations were actually done outside of the Fortran program; the program was just used to calculate the TMDL components (i.e., the numbers in Tables 5.1 and 5.2).